MiniCPS - A Toolkit for Security Research on CPS Networks

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Established in collaboration with MIT

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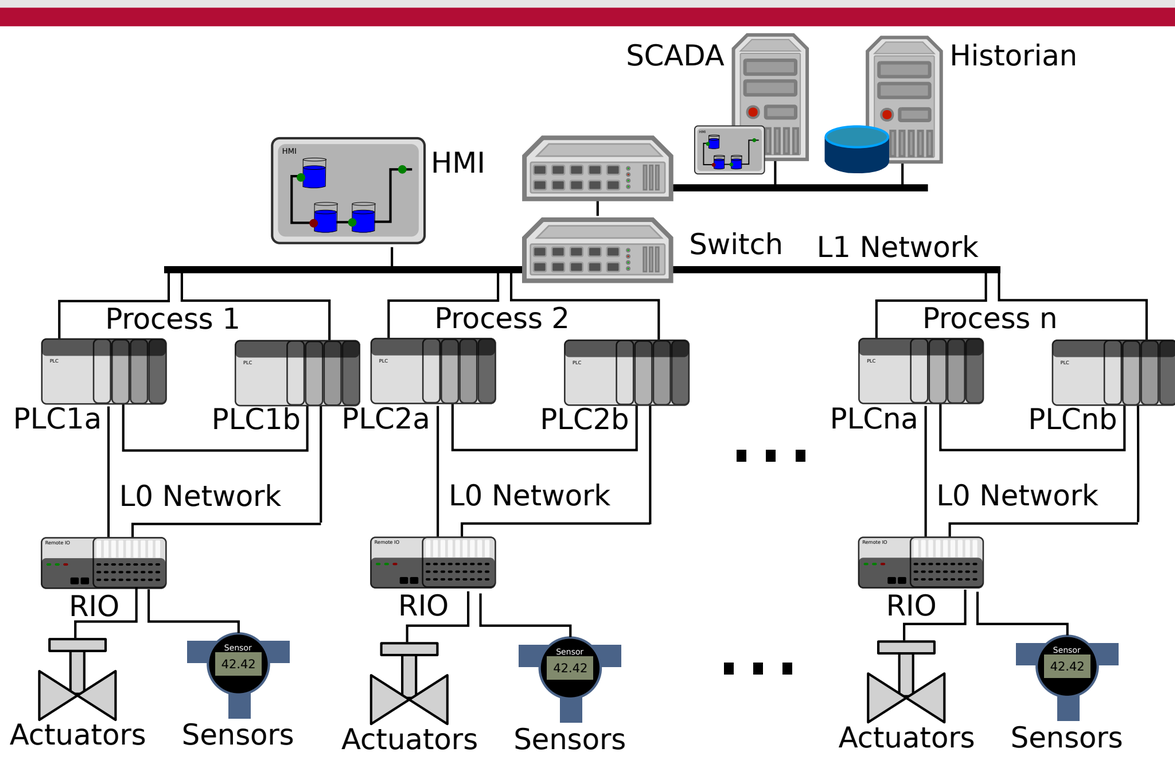
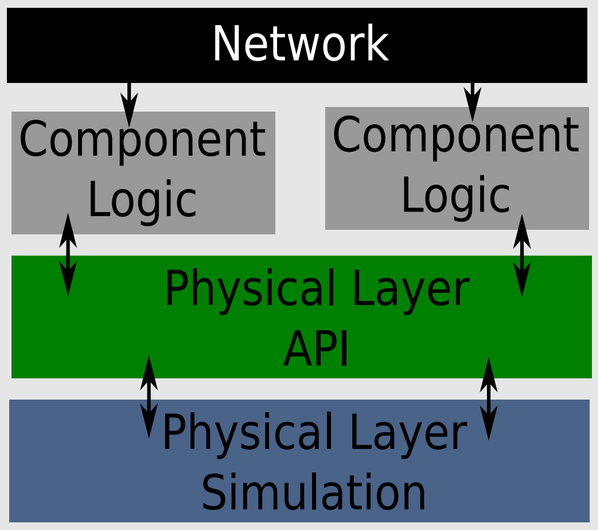
Problem Statement:

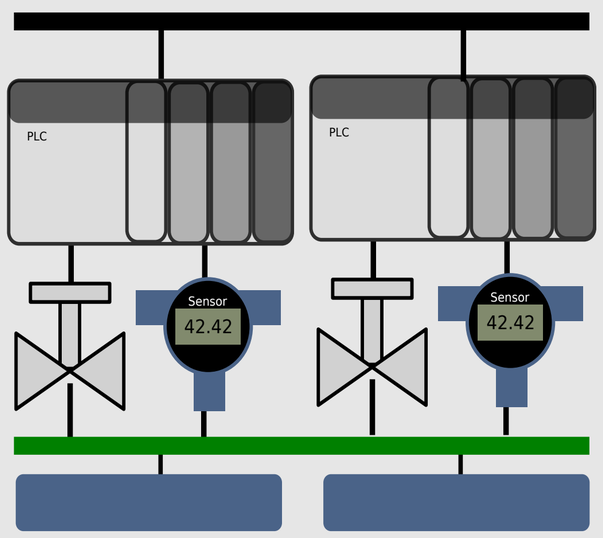
- Cyber-Physical Systems (CPS) Security is a major threat
- No simulation environment targeted to CPS research
- Physical Layer Interactions, Industrial Network Topologies
- Industrial Protocols: Ethernet/IP (CIP), Modbus/TCP.
- Simulation, emulation and co-simulation
- MiniCPS: Extensible, Reproducible CPS Research platform



MiniCPS:

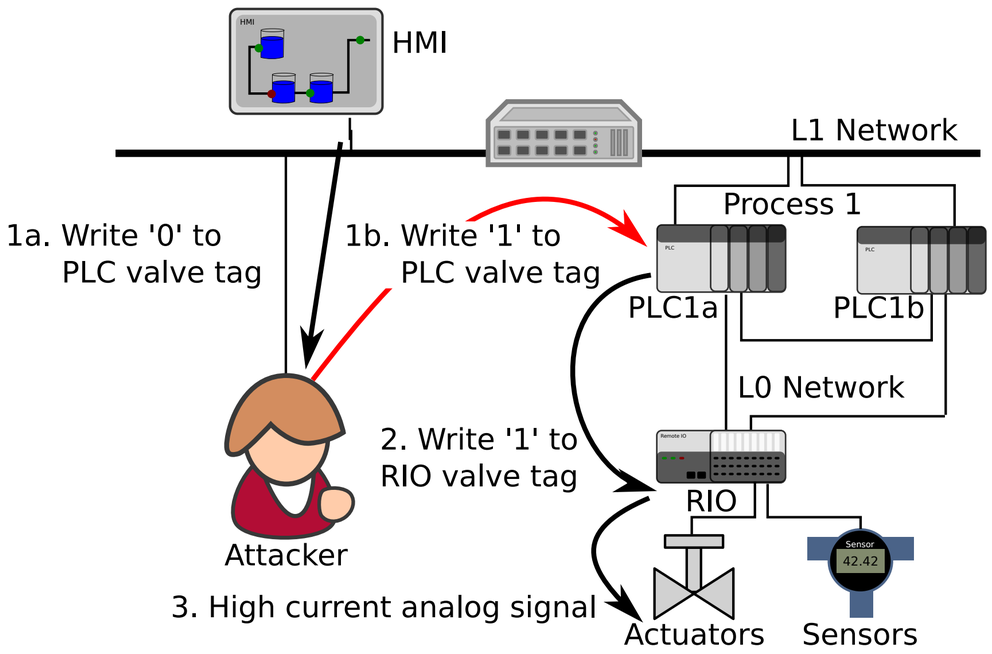
- Exchange Network Topologies and Configuration settings
- Test exploits and countermeasures in a safe but realistic manner
- Mininet emulator: lightweight, real traffic and SDN friendly (OpenFlow)
- Physical Process simulation scripts, e.g. MATLAB
- Component Logic simulation scripts, e.g Python





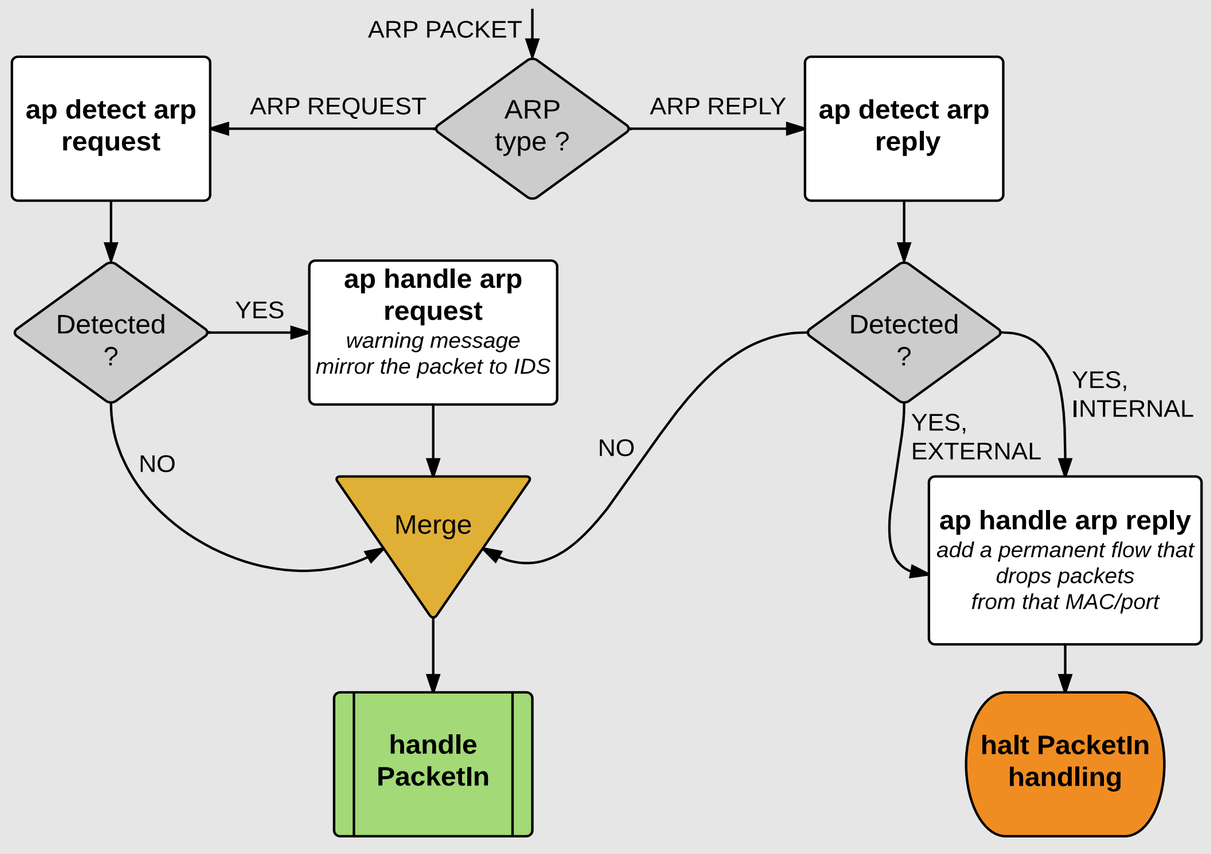
Man-in-the-Middle ARP spoofing Attacks:

- Designed and tested using MiniCPS. Validation on SUTD's Secure Water Treatment (SWaT) test bed
- Attacker between HMI and PLC1: custom ARP response packets to maintain the link
- Valve command is flipped Eg: HMI sends "open it" but PLC1 receives "close it"
- Water level is tampered Eg: PLC1 sends "overflow" but HMI receives "normal value"
- Simple, effective and stealthy using ettercap



Attack prevention using SDN:

- POX: event-driven, priority-based SDN framework.
- Attacker can both impersonate a new device or use an existing one (internal vs external)
- Attacker can both sniff the traffic and modify it on the fly (passive vs active)
- Controller pre-maps network addresses to set a known network state (proactive)
- Controller checks ARP suspicious packets and update the network state accordingly (reactive)
- Controller implements dedicated policy to mitigate the attack Eg: isolate the attacker



References:

"*MiniCPS: A Toolkit for Security Research on CPS Networks*" @ CPS-SPC '15: Proceedings of the First ACM Workshop on CPS Security and/or PrivaCy